

# **EXHIBIT C**

IN THE UNITED STATES DISTRICT COURT  
FOR THE EASTERN DISTRICT OF TEXAS  
MARSHALL DIVISION

FRACTUS, S.A.,

Plaintiff,

v.

AT&T MOBILITY LLC,

Defendant,

and

COMMSCOPE TECHNOLOGIES LLC and CELLMAX TECHNOLOGIES AB,

Intervenor-Defendants.

SPRINT COMMUNICATIONS COMPANY, L.P., ET AL.,

Defendants,

and

COMMSCOPE TECHNOLOGIES LLC and CELLMAX TECHNOLOGIES AB,

Intervenor-Defendants.

T-MOBILE US, INC., ET AL.,

Defendants,

and

COMMSCOPE TECHNOLOGIES LLC and CELLMAX TECHNOLOGIES AB,

Intervenor-Defendants.

CELLCO PARTNERSHIP D/B/A ~~VERIZONE~~VERIZON WIRELESS,

Defendant,

and

COMMSCOPE TECHNOLOGIES LLC,

Intervenor-Defendant.

Case No. 2:18-cv-00135-JRG

LEAD CASE

Case No. 2:18-cv-00136-JRG

Case No. 2:18-cv-00137-JRG

Case No. 2:18-cv-00138-JRG

DECLARATION OF DR. STUART LONG IN SUPPORT OF PLAINTIFF FRACTUS, S.A.'S  
CLAIM CONSTRUCTIONS

I, Stuart Long, Ph.D., declare as follows:

1. My full name is Stuart A. Long. I am currently a Professor in the Department of Electrical and Computer Engineering and Associate Dean of Undergraduate Research and the Honors College at the University of Houston.
2. I have studied, taught, and practiced electrical engineering and directly related fields for over 45 years. I hold degrees from Rice University (Bachelor of Arts in Electrical Engineering, magna cum laude, 1967, Master of Electrical Engineering, 1968) and Harvard University (Ph.D. in Applied Physics specializing in Applied Electromagnetics, 1974). I have been a registered Professional Engineer in the State of Texas since 1986.
3. I worked at Collins Radio Corporation in Dallas, Texas, in the amplifier design group during the summer of 1967, just after graduating with a Bachelor's degree from Rice University. After returning to Rice University and graduating with a Master's degree in 1968, I worked for General Dynamics in Fort Worth, Texas in their antenna design group developing aircraft antennas until 1969. At that time I enrolled in graduate school at Harvard University where I was both a teaching assistant and a research assistant. During the summers of 1970 and 1971, I worked at the Los Alamos Scientific Laboratories in Los Alamos, New Mexico, designing and developing antennas and other sensing devices for the linear proton accelerator being constructed at the time. After receiving a Ph.D. from Harvard University in 1974, I joined the faculty of the Department of Electrical Engineering at the University of Houston, located in Houston, Texas, as an Assistant Professor. I was promoted to Associate Professor with tenure in 1979, and to Full Professor in 1985. I served as Acting Chair of the Department of Electrical Engineering from 1981-1983, and then as permanent Chair from 1983-1995. A copy of my CV is attached as Exhibit 1.
4. If called upon to do so, I could and would testify truthfully as follows:
5. Based on my experience in the art and my study of the antenna designs disclosed in the asserted patents, a person of ordinary skill in the art would be an individual who, as of the relevant point in time, had an accredited master's degree in electrical engineering with an emphasis in electromagnetics, and at least ~~5~~five years of experience with antenna design; or

alternatively had a doctorate in electrical engineering with an emphasis in electromagnetics, and at least 2two years of experience with antenna design.

6. I understand that a patent claim is invalid if it is indefinite. I further understand that to satisfy the definiteness requirement, a claim must inform a person of ordinary skill in the art of the claimed invention's scope with reasonable certainty when read in view of the specification and prosecution history.

7. I understand that defendants contend that the ~~following~~ claim ~~term~~term "situated around" as used in ~~claim 38~~claims 15, 19, and 24 of the '918 patent, claims 6, 16, and 27 of the '768 patent, claims 1, 9, 7 and 119 of the '493870 patent, and claim 814 of the '940256 patent ~~are indefinite: (i) "a wavelength of the [first/second] continuous frequency range"; (ii) "an operating wavelength of the first frequency range"; (iii) "an operating wavelength of the second contiguous frequency range"; (iv) "wavelength of a [first/second] frequency band"; and (v) "operating wavelength of the [first/second] frequency band."~~is indefinite.

8. These claims are not indefinite because they inform a person of ordinary skill in the art of the scope of the claims with reasonable certainty when read in view of the specification and prosecution history. Specifically, the specification and claims, in light of the knowledge of a person of ordinary skill, provide clear notice of the boundaries of this claim limitation. ~~The wavelength of an electromagnetic wave is the distance over which the waveform completes one cycle and then begins to repeat itself. As a person of ordinary skill knows, there is a simple formula for calculating the wavelength for a given frequency: wavelength = velocity of propagation / frequency. For a given range of frequencies, there is a corresponding range of wavelengths. Thus, a person of ordinary skill would understand that "a wavelength" of "a frequency range" means one of the wavelengths that corresponds to a frequency in the given range of frequencies. See, e.g., '191 patent<sup>1</sup> at 2:2-7. A person of ordinary skill would also understand that the "operating wavelength" or "working wavelength" is just the wavelength resulting from the chosen (or working or operating) frequency. See, e.g., '191 patent at 1:63-66, 2:22-28, 5:17-45, 7:21-25.~~

9. ~~I understand that defendants contend that the claim term "a ratio between a working frequency of the third frequency band and a working frequency of the second frequency band is around 2.33/2" as used in claim 18 of the '493 patent is indefinite. This claim is not indefinite because it informs a person of ordinary skill in the art of the scope of the claim with reasonable certainty when read in view of the specification and prosecution history. Specifically, the specification and claim, in light of the knowledge of a person of ordinary skill, provide clear notice of the boundaries of this claim limitation. In this context, the term "around" means "approximately." This sort of approximation in antenna engineering is well understood. Since all practical electronic devices operate over some range or band of frequencies, the exact operating or working frequency varies over this prescribed bandwidth. So the ratio of two frequencies in separate frequency bands will vary around some central value, and thus, the ratio is given as an approximation.~~

<sup>1</sup>—My citations are to the common specification of the '191 patent for the sake of consistency but the citations apply to the specific claims being discussed.

~~10. — I understand that defendants contend that the following claim terms as used in claims 12 and 14 of the ‘918 patent, claim 13 of the ‘768 patent, and claim 1 of the ‘493 patent are indefinite: (i) “wherein the working frequency bands are situated around 900 MHz and 1800 MHz”; (ii) “wherein the working frequency bands are situated around 900 MHz, 1800 MHz, and 2100 MHz”; (iii) “wherein at least one of the plurality of working frequency bands is situated around 1900 MHz”; and (iv) “an operating frequency of the first continuous frequency range is situated around 900 MHz and an operating frequency of the second continuous frequency range is situated around 1800 MHz.”~~11. — These claims are not indefinite because they inform a person of ordinary skill in the art of the scope of the claims with reasonable certainty when read in view of the specification and prosecution history. Specifically, the specification and claims, in light of the knowledge of a person of ordinary skill, provide clear notice of the boundaries of this claim limitation. In the context of these claims, the phrase “situated around” means “includes.” Thus, for example, when a “working frequency band[ is] situated around 1900 MHz,” this means that the working frequency band includes 1900 MHz within the frequency range. In antenna engineering a frequency band is often referred to by simply using an easy to remember single frequency that is within the band rather than always calling it by its lower and upper frequency limits. Also, ~~as discussed above~~, a person of ordinary skill would also understand that the “working frequency band” or “operating frequency” is just the chosen frequency band or frequency. See, e.g., ‘191 patent at 1:15-18, 3:30-32, 3:35-37, 5:18-45, 6:3-7, 6:15-17, 6:35-42, 6:58-65, 7:56-62, 8:37-41, Figs. 3, 4, 7 & 8.

9. I understand from the declaration dated January 14, 2019 submitted by Dr. Mohammad Ali on behalf of defendants, that defendants contend the term “situated around” is a term of degree. On the contrary, a person of ordinary skill in the art would not understand “situated around” to be a term of degree. It does not mean “about” or “approximately.” The term “situated around” is used in connection with the term “frequency bands” (or, in one instance, “operating bands”), which defines specific ranges of frequencies. A person of ordinary skill would understand that frequency band is “situated around” a given frequency if its lower bound is below that frequency and the upper bound above it—in other words, it includes the specified frequency.

10. Moreover, because the term “situated around” is used in conjunction with “frequency band” the term does not lack boundaries that would be understood by a person of ordinary skill. The patent describes frequency bands designated for cellular service, such as the GSM 900 and GSM 1800 bands. ‘191 patent at 4:40-50. “GSM” is an abbreviation for “Global System for Mobile Communications,” one of the cellular service (or standards) in use at the time. As the patent itself describes, the GSM 900 and GSM 1800 are two bands designated for the GSM service, utilizing the 890 MHz–960 MHz and 1710 MHz–1880 MHz spectrum, respectively. ‘191 patent at 7:34-35. Thus, a person of ordinary skill would understand that the frequency band has objective boundaries.

~~12. 11. I understand that defendants contend that the following claim terms as used in claims 1, 11, and 18 of the ‘493 patent, claim 8 of the ‘940 patent, and claims 1, 6, 8, 11, 1 and 12 of the ‘305 patent, are indefinite: (i) “...and substantially arranged along a first direction with respect to a longitudinal axis...”; (ii) “...substantially arranged along a longitudinal direction...”; (iii) “a plurality of antenna elements arranged on the ground plane layer along a longitudinal direction of the antenna array”; (iv) are indefinite: (i) “...substantially vertical direction of the ground plane”;~~

and (vii) “at least the plurality of radiating elements of the first set and at least a plurality of radiating elements of the third set are substantially aligned with respect to a first vertical direction of the ground plane.”

~~13.~~ 12. These claims are not indefinite because they inform a person of ordinary skill in the art of the scope of the claims with reasonable certainty when read in view of the specification and prosecution history. Specifically, the specification and claims, in light of the knowledge of a person of ordinary skill, provide clear notice of the boundaries of this claim limitation. In the context of these claims the word “substantially” means “approximately.” This sort of approximation in antenna engineering is well understood. The device can function properly if the arrangement and geometry are substantially (approximately) as designed. Thus, elements that are “substantially arranged” along a direction are ones that are arranged approximately along that direction, but absolute precision is not required. A person of ordinary skill in the art would understand how to assess whether the elements were substantially arranged along a particular direction. Similarly, elements that are “substantially vertical” are ones that are approximately vertical. Again, a person of ordinary skill in the art would understand how to assess whether the elements were substantially vertical.

~~14.~~ 13. I understand that defendants contend that the following claim terms as used in ~~claims 17 and 31 of the ‘768 patent,~~ claim 1 of the ‘870 patent, and claim 11 of the ‘256 patent, are indefinite: (i) “at least one mono-band antenna element of one of the plurality of mono-band antenna arrays operating at a first working frequency band of the plurality of working frequency bands is repositioned to coincide with a nearest mono-band antenna element of another one of the plurality of mono-band antenna arrays operating at a second working frequency band of the plurality of working frequency bands”; and (ii) “at least one first-band antenna element of the first antenna array is repositioned to coincide with a nearest second-band antenna element of the second antenna array.”

~~15.~~ 14. These claims are not indefinite because they inform a person of ordinary skill in the art of the scope of the claims with reasonable certainty when read in view of the specification and prosecution history. Specifically, the specification and claims, in light of the knowledge of a person of ordinary skill, provide clear notice of the boundaries of this claim limitation. In the context of the patents, “repositioning” is one part of the process described in the patent for determining the location of the elements in the claimed multiband array. The patent provides clear instructions, which would be readily understood by a person of ordinary skill, for determining the position of the elements in the multiband array.

~~16.~~ 15. As described in the specification, the positions of the elements in a multiband interlaced antenna array are determined using the process described in the patent, which begins with the configurations of the mono-band arrays that cover each of the required frequency bands. See, e.g., ‘191 patent at 2:62-3:10, 5:62-6:7, 6:24-57, 6:66-7:25, 8:29-50, Figs. 5-10. The specification would be understood by a person of ordinary skill in the art to provide clear guidance with respect to the use and placement of multiband elements in the claimed multiband antenna array, the positioning of various elements in the array (including the repositioning of elements where the elements in the mono-band arrays do not come together in the same position), and the use of either a combination of mono-band and multiband elements or exclusively multiband elements in the array. The mono-band arrays are juxtaposed, meaning that they are overlapped to ascertain

and compare the positions of the elements in each of the arrays. In those positions where the mono-band array elements come together, the patent directs that a multiband antenna element be used, with said multiband element capable of working simultaneously in the frequency bands of the mono-band antenna elements. In some instances the elements of the mono-band arrays do not come together or coincide (as will commonly be the case when the ratio between the frequency bands is not an integer) and the patent directs that in such circumstances that the elements be “repositioned,” that is that the elements be moved so that elements of the different mono-band arrays do come together and so that the position of the multiband element can be determined. The specification provides clear guidance, which would be well understood by a person of ordinary skill in the art, as to where the elements should be repositioned to determine the specified location for the multiband element. This is illustrated in Figure 5 of the patent specification, among other places in the patent. The locations of the mono-band antenna elements in the mono-band arrays are shown in Figures 5.1 5.2, and 5.3. Figure 5.4 shows what the multiband antenna array configuration would be before repositioning. In order to provide the solution claimed in the patent, the specification describes in detail the repositioning of elements in order to determine a location where they come together and a multiband element can be used. Specifically, it directs that the lowest frequency antenna elements should be repositioned until they coincide with the nearest highest frequency elements. Then the antenna elements that coincide in a particular position are replaced with a single multiband antenna element in that position. An example of the final configuration is shown in Figure 5.5. To be clear, the resulting multiband array may consist entirely of multiband elements, as clearly illustrated in Figure 7 and described at, e.g., ‘191 patent at 2:58-3:5, 7:43-67.

16. I understand that defendants contend that the following claim terms as used in claims 1, 16, and 23 of the ‘768 patent and claim 1 of the ‘870 patent are indefinite: (i) “radiation and impedance patterns that are similar in a plurality of working frequency bands”; and (ii) “radiation and impedance patterns that are similar in a plurality of the plurality of working frequency bands.”

~~17. I understand that defendants contend that the following claim terms as used in claims 1, 9, 16, 23, 30, and 38 of the ‘768 patent, and claims 1, 11, and 20 of the ‘870 patent, are indefinite: (i) “the electromagnetically connected antenna elements are adapted to interact with each other to establish radio-electric characteristics with respect to radiation and impedance patterns that are similar in a plurality of working frequency bands”; and (ii) “the single multiband antenna element comprises a plurality of electromagnetically coupled portions which are adapted to interact with each other to establish radio-electric characteristics of the single multiband antenna element with respect to radiation and impedance patterns that are similar in a plurality of the plurality of working frequency bands.”~~<sup>18</sup>. — These claims are not indefinite because they inform a person of ordinary skill in the art of the scope of the claims with reasonable certainty when read in view of the specification and prosecution history. Specifically, the specification and claims, in light of the knowledge of a person of ordinary skill, provide clear notice of the boundaries of this claim limitation. A person of ordinary skill would understand the term referring to “radiation and impedance patterns” refers to radiation patterns and impedance (or radiation patterns and impedance patterns, which would, in context, have the same meaning). A “radiation pattern” is a graphical representation of the spatial radiation properties of an antenna as a function of angle and the “impedance” is the ratio of the voltage and current at the feed point of the antenna—which is related to a measure of how much of the energy from the base station is

transmitted as radio waves rather than being reflected back. The radiation pattern of a base station antenna is important to provide coverage to the desired areas, without undesirable pattern characteristics such as nulls that would limit coverage in the desired area. Matching the impedance of an antenna ~~to~~over the desired frequency band is important to ensure that the antenna operates ~~efficiently~~effectively—an antenna that is poorly matched ~~for~~over a given frequency range will not operate ~~efficiently~~effectively in that range, though it might operate ~~efficiently~~effectively at a different frequency range. It is therefore important that ~~at~~over the desired frequency ranges that the multiband antennas used in a base station antenna array have the correct radiation pattern and impedance at the frequencies of the frequency bands covered by that antenna.

~~19.~~18. A person of ordinary skill in the art would further understand that the geometry of ~~a simple mono-band~~an individual antenna can be adapted to provide similar radiation and impedance characteristics over multiple frequency bands. The multiband behavior of the antenna elements is the result of their geometry, which is made up of electromagnetically coupled portions or areas of the conducting structure that allow multiple current paths associated with operation at the various frequency bands. Non-exclusive examples of such multiband antennas are provided in the patent specification, including Fractus's own fractal, multi-triangular and multilevel antennas. See, e.g., '191 patent at Figs. 7, 8, 11, 12, 5:10-15, 5:46-53, 7:43-67, 8:15-28, 9:29-55, 10:5-19. A person of ordinary skill in the art would understand that while such multiband antennas may include geometries where one discrete part of the antenna (for example, one patch in a stacked or dual patch antenna) may be principally associated with operation at a given frequency, for other such multiband antennas (including the multiband antennas specifically referenced in the patents) there are no discrete, separate sections that are associated with operation ~~on~~at only one frequency. Rather, the portions of such multiband antennas that allow for operation or resonances at both larger and smaller frequencies may be overlapping. When the overall structure is fed, depending on the frequency chosen, either all the conducting portions (which are also described in the patent as elements, though using a different meaning than that in the claims of the patent) or some subset of the portions will be "active" and provide the required radiation characteristics.

19. I understand from the declaration dated January 14, 2019 submitted by Dr. Mohammad Ali on behalf of defendants that defendants contend that the phrase "radiation and impedance patterns" is indefinite. In my opinion, a person of ordinary skill in the art would readily understand the meaning of the phrase and would not be confused by reference to "impedance patterns." From the context of the interlaced patents, it would be perfectly evident that the impedance to be considered is the impedance at different frequencies—that is, the behavior of impedance across the various frequencies considered. It would be readily understood by a person of ordinary skill in the art that when selecting multiband elements, an antenna designer would want to ensure that they are functional at the desired frequency bands, and in doing so would consider whether they have the correct, similar impedance at those desired frequencies. From that, it would be apparent to a person of ordinary skill in the art that "impedance pattern" in the context of the interlaced patents is the impedance at different frequencies.

20. That is all the more apparent in consideration of the fact that as with radiation, impedance measurements may be and often are recorded and described using a graphical representation. An example of this is in US Patent No. 8,941,541, attached as Exhibit 2, which is referenced in the

asserted Interlaced patents and the claims of which are directed to Fractus's multilevel antennas, a type of multiband antenna:

[Image]

'541 patent at Fig. 10 showing antenna radiation '541 patent at Fig. 9 showing antenna impedance The graph in Figure 9 depicts the return loss, which is a measure related to the impedance at various frequencies, which are shown along the horizontal axis. These graphical representations are also commonly used in industry, an example of which is copied below from product documentation that accompanies the antenna models shipped to customers by base station antenna manufacturer Radio Frequency Systems (RFS) showing the voltage standing wave ratio ("VSWR") plot which corresponds to the impedance of the antenna over different frequencies. See Exhibit 4.

[Image]

21. I also understand from Dr. Ali's declaration that defendants now claim that the term "impedance pattern" is not used in the field of radio engineering. While not extremely common, the term is used and would be readily understood by a person of ordinary skill in the art. For example, the 1998 paper titled "Study of Impedance and Radiation Properties of a Concentric Microstrip Triangular-Ring Antenna and Its Modeling Techniques Using FDTD Method" by Iti Saha Misra and S. K. Chowdhury (attached as Exhibit 3), describes the measurement of both impedance patterns and radiation patterns. Both are graphically represented:

[Image]

Fig. 6(b) showing impedance pattern                      Fig. 7 showing radiation pattern

22. By comparing these graphical representations a person of ordinary skill in the art would understand what it means to have "similar" and "substantially similar" radiation and impedance patterns. "Similar" and "substantially similar" would be understood in context to mean that the radiation patterns and impedance patterns are sufficiently similar to provide operation on the relevant frequency bands—in other words, sufficiently similar so that the antennas are appropriately matched at the desired frequency bands. A person of ordinary skill in the art and knowledgeable about the specific application of the antenna would be able to determine that patterns with slightly different gains, directivities, beam widths, side lobe levels, directions of maximum radiation, polarization, or number of side lobes would still be "similar" if the operation of the antenna remained functional. Those terms are not unbounded but would be understood here to be tied with the functionality that is described in the patent, namely, transmission and reception on multiple frequency bands by a base station using the antenna elements.

I declare under penalty of perjury that the statements above are true and correct.

Executed this ~~14~~<sup>13</sup><sup>th</sup> Day of ~~January~~<sup>February</sup>, 2019.

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Dr. Stuart A. Long